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Preface

The purpose of this manual is to set objectives, standards, guidelines and procedures for a variety of forest management activities in Saskatchewan. Saskatchewan Environment (SE) has prepared this manual in accordance with section 19.1 of *The Forest Resources Management Act* (FRMA). This section of the Act allows for the development of four manuals – Forest Planning, Forest Operations, Scaling and Compliance. Each manual will contain details on applicable objectives, standards, guidelines and procedures to be followed for a particular subject area by a licensee undertaking forest operations.

The following terminology will be used in the manuals:

An **objective** states a desirable forest practice or future condition of a forest resource or forest use, which is attainable through actions of the licensee. Objectives are specific and any linkages to higher-level management plan objectives and targets must be described. The objective sets the context and rationale for developing procedures, standards and guidelines. Objectives may change from time to time in response to new public values and licensee needs, and in response to new knowledge inputs, much of which will come from monitoring the results of forest operations.

A **standard** is a specific measurable activity, result or unit of measure. Good standards are measurable, scientifically sound, operationally feasible, linked to management objectives, and integrated with other standards. SE will enforce a licensee's adherence to the standards and can modify standards when the monitoring of results or new knowledge indicates a change is required.

Guidelines are recommended practices and are options for achieving standards and objectives given expected conditions. A licensee may deviate from the guideline when unforeseen or site-specific circumstances require an alternate approach. Although SE will not enforce guidelines, their effectiveness or use of alternate practices will be considered in audits.

A **procedure** is the sequence of actions used to ensure consistent assessment of standards across the province and concentrates on methods rather than results. SE may make it a requirement to follow a specific procedure.

The latest version of this manual is available at the Saskatchewan Environment web site (www.se.gov.sk.ca/forests/forestmanagement/Sask_Leg_Manuals.htm). Organisations or agencies that are registered with the Department will receive notification of changes or additions to the manuals. New documents will be mailed to registered manual holders to include in sections identified in this manual. Provincial standards contained in this manual supercede any existing FMA standards and guidelines.

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GLOSSARY

The purpose of this glossary is to define and explain terms, used in forestry or otherwise, which appear in various sections of the Forest Operations Manual.

Definitions, which have been taken fully, modified or adapted from an existing source, are referenced by the following abbreviations:

Acton	Acton, D.F., G.A. Padbury and C.T. Stushnoff. 1998. The Ecoregions of Saskatchewan. Saskatchewan Environment and Resource Management (ed.). Canadian Plains Research Centre, University of Regina. 205 pp.
ARSM	Alberta Regeneration Survey Manual. Alberta Sustainable Resource Development, Forest Management Branch. May 1, 2003.
D&D	Dunster & Dunster, Dictionary of Natural Resource Management. UBC Press, 1996.
ESWG	Ecological Stratification Working Group. 1995. A National Ecological Framework for Canada. Agriculture and Agri-Food Canada, Research Branch, Centre for Land and Biological Resources Research and Environment Canada, State of the Environment Directorate, Ecozone Analysis Branch, Ottawa/Hull.
R&O	Radosevich, S.R.; Osteryoung, K. 1987. Principle governing plant-environment interactions. Pp 105-157 in Walstad, J.D. and Kuch, P.J. 1987. Forest vegetation management for conifer production. John Wiley & Sons. New York. 523 pp.
SSG	Silvicultural Systems Guidebook, Forest Practices Code of British Columbia, April 1995.
VPI	Vegetation Pattern Indicators, Version 6.3. Saskatchewan Environment and Resource Management. 2001.
Wiken	Wiken, E. (compiler) 1986. Terrestrial Ecozones of Canada. Ecological Land Classification Series, No. 19. Lands Directorate, Environment Canada, Ottawa. Ecological Stratification Working Group. 1995. A National Ecological Framework for Canada. Agriculture and Agri-Food Canada, Research Branch, Centre for Land and Biological Resources Research and Environment Canada, State of the Environment Directorate, Ecozone Analysis Branch, Ottawa/Hull.

Advance Growth	A tree that was established prior to harvest.
Clearcut System	A type of silvicultural system, based on a harvesting method in which all merchantable timber in a designated area is harvested in a single entry. Clearcutting results in a new, even-aged stand of trees, which can be naturally or artificially created. Clearcutting can be implemented in blocks, strips, or patches. (Modified D&D). Refer also to Silvicultural System
Clump	A contiguous area of less than 2 ha that includes more than four trees, completely enclosed within a disturbance. Clumps are essentially small islands, and the distinction is a practical and computational convenience. (Modified VPI) Refer also to Silvicultural System.
Competition	The mutually adverse effects of two plants that utilize the same resource (e.g. light, nutrients, moisture, growing space). Often refers to the suppression of one plant species by another.
Control line	A line transect established across a regeneration survey block at intervals for control of plot location. (Modified ARSM)
Deleted Plot	A plot landing in areas the renewal liability holder is not obligated to reforest. These would include islands of unharvested land (treed and non-treed), and other provincially approved land uses excluded from the regeneration area within a harvest block (refer to section 2.1.3 of the Regeneration Assessment document).
Density	The number of trees per hectare.
Disposition	A land designation granted pursuant to the Provincial Lands Act and Regulations and the Resource Lands Regulations, 1989.
Ecoregion	A subdivision of the ecozone characterized by distinctive large order landforms or assemblages of regional landforms as expressed by vegetation, soils, water, and regional human activity patterns or uses. Saskatchewan contains 11 terrestrial ecoregions. (Modified Wiken)
Ecozone	An area of the earth's surface representative of broad mosaics formed by the interaction of climate, human activity, vegetation, soils, geological, and physiographic features of the country. The ecozone lies at the top of the ecological hierarchy. Saskatchewan contains 4 terrestrial ecozones. (Modified ESWG)
Establishment Assessment	The establishment assessment is the first regeneration assessment that reports regeneration success in relation to establishment assessment standards. This assessment is done between 4 and 5 operating years after the end of the operating year of harvest.
Free- to-grow Assessment (FTG)	The FTG assessment is a regeneration assessment that reports regeneration success in relation to FTG assessment standards.. This assessment is done between 8 and 14 operating years after the end of the operating year of harvest.

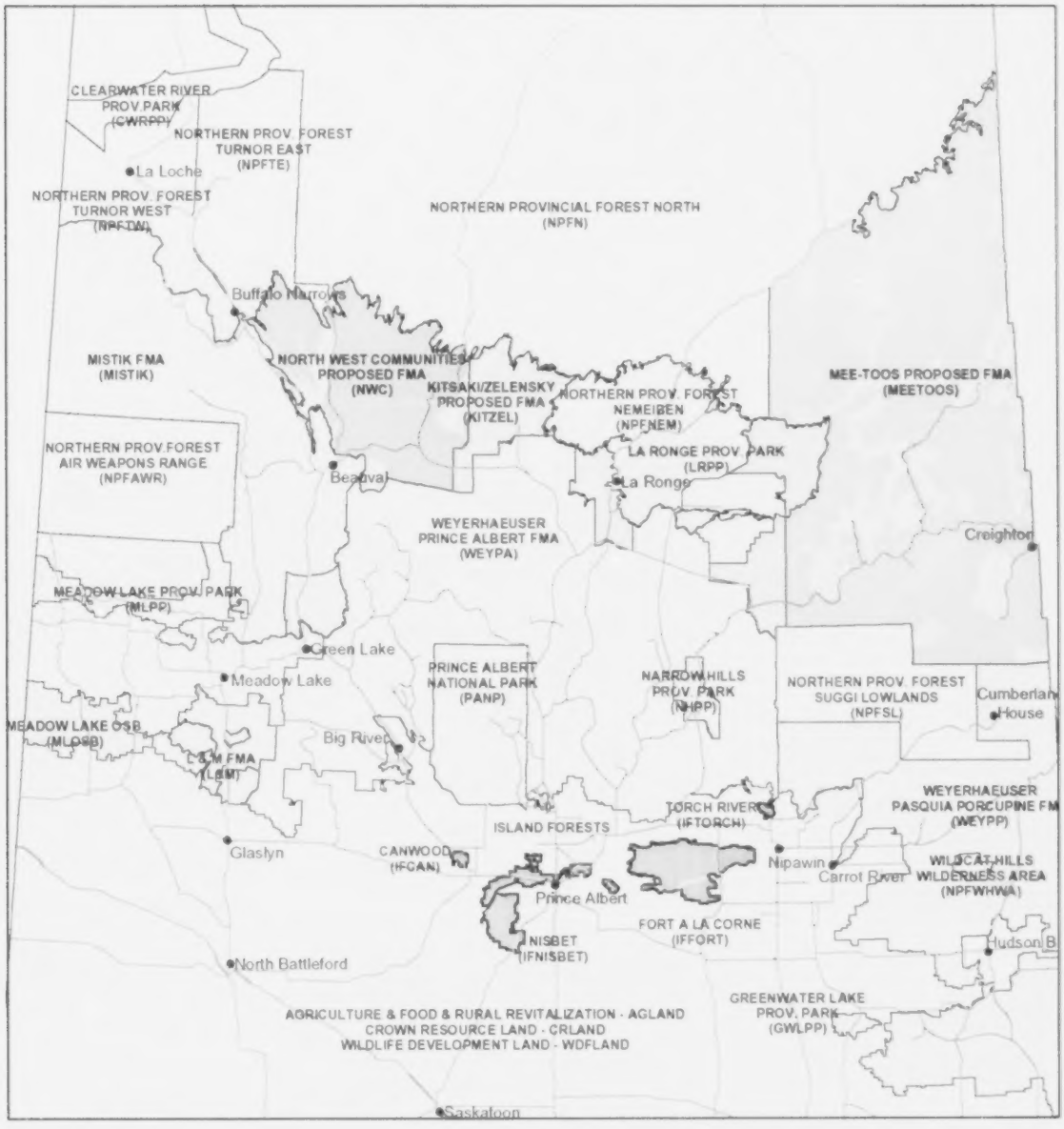
Free-to-grow	Free-to-grow is a state or condition assigned to a sampled unit (i.e., a tree, a group of trees, a stand, or a harvested area) as a result of its assessment against a set of regeneration standards that provide a reasonable assurance that the future forest condition defined by the standards will be achieved
Hardwood (deciduous)	A broad-leafed tree, losing its leaves (or a proportion of them) at the end of a season's growth.
Harvest block	A unique polygon that is defined by the operating year in which timber harvesting was completed, whereby all approved merchantable timber is skidded to roadside. A harvest block does not include inter-block roads.
Heritage property	As defined in the Heritage Property Act and Regulations, 2002.
In-block Road	A road constructed by a licensee that originates and terminates within the same harvest block, used exclusively for the decking of wood originating from within the block.
Individual Trees	Are single trees or groups of four or less trees completely enclosed within a disturbance. (Modified VPI). Refer also to Silvicultural System.
Inter-block Road	A road constructed by a licensee which connects operating areas and harvest blocks.
Island	A contiguous area at least 2 ha in size that is completely enclosed within a disturbance. (Modified VPI)). Refer also to Silvicultural System.
Landing	The area directly adjacent to a road used for the decking of timber.
Leader	A tree's most recent complete height growth increment.
Non-productive area	An area that was incapable of supporting tree growth before harvest, and are primarily limited to wetlands or extremely rocky sites.
Not Sufficiently Regenerated (NSR)	An individual survey plot, portion of a harvest block, or an entire harvest block that did not meet the associated regeneration assessment standards for the type of survey conducted.
Operating Year	The time period from April 1st to March 31st. (e.g. 2003-2004 operating year is from April 1st, 2003 to March 31st, 2004)
Regeneration Survey Plot	A regeneration survey plot is 1/1000 ha or 10m^2 in size, circular in shape, and has a radius of 1.78m.
Renewal Liability Holder	The party responsible for forest renewal activities on Provincial Forest, to the liability limits set out in a license (as defined in the Forest Resources Management Act or Regulation).
Riparian Areas	Riparian areas are ecotones or interfaces between terrestrial and aquatic ecosystems. Gradients in environmental conditions, ecological processes, and species composition make these areas some of the most structurally and functionally diverse and dynamic portions of forested landscapes.

Riparian Management Areas	Distinct spatial boundaries designated to achieve specific management goals for riparian areas and may contain zonation or elements including both aquatic or terrestrial environments associated with or outside the riparian ecotone.
Root Collar	The base of a seedling/tree where the root ends and the stem begins. Sometimes characterized by a node.
Silvicultural Systems	Planned programs of treatments throughout the life of the stand to achieve stand structural objectives based on integrated resource management goals. A silvicultural system includes harvesting, regeneration and stand-tending methods or phases. It covers all activities for the entire length of a rotation or cutting cycle. Silvicultural systems are classified according to the method of harvesting mature stands. (Modified SSG) **Types of Silvicultural Systems:** **Clearcut** is a type of silvicultural system, based on a harvesting method in which all merchantable timber in a designated area is harvested in a single entry. Clearcutting results in a new, even-aged stand of trees, which can be naturally or artificially created. Clearcutting can be implemented in blocks, strips, or patches. (Modified D&D) **Variable Retention** is a type of silvicultural system based on a harvesting method in which most merchantable timber within a designated area is harvested in a single entry. Some of the merchantable timber is retained in islands, clumps, and individual trees scattered throughout the block resulting in a new, even-aged stand of trees, which can be naturally or artificially created. **Island** is a contiguous area at least 2 ha in size that is completely enclosed within a disturbance. (Modified VPI) **Clump** is a contiguous area of less than 2 ha that includes more than four trees, completely enclosed within a disturbance. Clumps are essentially small islands, and the distinction is a practical and computational convenience. (Modified VPI) **Individual Trees** are single trees or groups of four or less trees completely enclosed within a disturbance. (Modified VPI)
Slash Pile	A concentration of logging debris or residue left on the ground as a result of forest and other vegetation being altered by forest operations or other land use activities
Softwood (conifer)	A tree that usually but not always has needle leaves or scale leaves and that bears separate male and female cones. It is usually, but not always, evergreen.

Stand Tending	Activities such as thinning, spacing, removal of mistletoe infected trees, and weed and brush control, carried out in already established stands. (D&D)
Stocking Percent	The sum of all the SR plots on the regeneration survey block, divided by the total number of valid plots, multiplied by 100 to express as a percent. (Modified ARSM)
Sufficiently Regenerated (SR)	A state or condition where an individual survey plot, portion of a harvest block, or an entire harvest block meets the associated regeneration assessment standards for the type of survey conducted.
Survey line	Survey lines run perpendicular to the control lines, parallel with each other and at a calculated spacing. Plots are located along the survey line. (ARSM)
Temporarily flooded area	An area inundated with surface water during a period of seasonal run-off or an extreme rainfall event. This occurrence should not be mistaken for a permanently flooded area.
Valid Plot	A plot within a regeneration assessment that is assessed for its attributes in order to establish it's stocking condition and the density of trees on it. A "deleted plot" is not a valid plot.

Appendix A

Saskatchewan's Crown Forests



Legend

Towns Rivers Waterbodies

Boundaries are approximate.
This document is not intended for use as a legal representation of Agreements, License Areas, or Boundaries.

Scale:
1 : 3,300,000

N

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Forest Ecosystems Branch
Feb 12, 2004

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REGENERATION ASSESSMENT

MARCH 2004

Regeneration Assessment

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Forest Service
March 2004

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1 Introduction

Saskatchewan's provincial forests contain a variety of forest ecosystems, which support the multiple interests of various stakeholders, including aboriginal and community groups. In the commercial forest zone, Crown forests are managed according to ecosystem-based principles. Prompt reforestation is imperative to produce a sustained flow of forest products and to maintain forest ecosystem health. Reforestation treatments used to establish new forests have a lasting impact on stand development.

The Forest Resources Management Act and *Regulations* require that all lands harvested are renewed, with a minimum goal of maintaining the long-term productive capacity of the forest and the integrity of ecosystem processes in the licence area. Measurable standards are essential for regulatory bodies, forest managers and the public to assess the success of forest regeneration. Regeneration assessment surveys are used to measure the achievement of these standards.

The regeneration assessment component of the Forest Operations Manual establishes minimum regeneration standards and outlines two key survey periods and processes to collect regenerating stand data. The establishment assessment provides assurance early in the regeneration phase of a forest stand that adequate stocking is present on a site (established either artificially or naturally) to contribute to the short-term development of that stand. Achievement of the free-to-grow (FTG) standards in the FTG assessment that follows provides reasonable assurance that achievement or maintenance of the desired future forest condition is likely.

The regeneration standards contained in this document have been established as minimum standards that forest renewal liability holders must meet or exceed. In the future, these standards should be incorporated into a licensee's wood supply analysis. Where a renewal liability holder proposes to exceed these standards, they must develop associated regeneration standards consistent with the wood supply assumptions.

Saskatchewan Environment (SE) is nearing completion of a forest ecosystem classification system, studying the linkages of regenerating forests to long-term wood supply, commencing implementation of a growth and yield program, and conducting research on successional pathways. The regeneration standards will be amended to incorporate new knowledge as it becomes available.

1.1 Objective

The objective of the regeneration assessment is to apply regeneration standards that should ensure adequate stocking, survival and growth rates of forest tree regeneration that, at a minimum, emulate natural yields. Establishing regeneration standards will help ensure that Saskatchewan's forests are promptly and effectively regenerated following forest harvesting and development activities.

1.2 Applicability of Regeneration Standards

The regeneration standards are applicable to all blocks harvested after March 31, 2004. Regeneration standards will apply to the renewal activities carried out by any renewal liability holder operating in the Provincial Forest, to the liability limits set out in the licence or in legislation (refer to Appendix A of the Forest Operations Manual for the forest areas of

Saskatchewan). The standards in this document apply to both clearcut and variable retention systems, which are the primary silvicultural systems used in the province.

Harvest blocks less than two hectares (ha) in size are exempt from the regeneration standards.

2 Regeneration Assessment

2.1 Standards Applicable To Both Establishment and Free-To-Grow Assessments

2.1.1 Acceptable Tree

To be tallied and contribute towards regeneration status, an acceptable tree must:

- Be listed in Table 1;
- Be alive;
- Be less than 10 metres tall (to accommodate advanced growth);
- Have a living crown (green foliage) that covers the top 50% of the tree height (softwoods only);
- Be free of lean in excess of 30 degrees from the vertical;
- Be a minimum of 10 cm in height for establishment assessments and a minimum of 30 cm in height for FTG assessments.

Table 1. Acceptable tree species by ecoregion.

Acceptable Species	Symbol	Churchill River Upland	Mid-Boreal Upland	Mid-Boreal Lowland	Boreal Transition	Cypress Upland
White Spruce	wS	Y	Y	Y	Y	Y
Black Spruce	bS	Y	Y	Y	Y	Y
Jack Pine	jP	Y	Y	Y	Y	
Balsam Fir	bF	Y	Y	Y	Y	
Tamarack	tL	Y	Y	Y	Y	Y
Trembling Aspen	tA	Y	Y	Y	Y	Y
Balsam Poplar	bP	Y	Y	Y	Y	Y
White Birch	wB	Y	Y	Y	Y	
White Elm	wE			Y		
Green Ash	gA			Y	Y	
Bur Oak	bO				Y	
Lodgepole Pine	lP					Y
Plains Cottonwood	pC					Y

Note: The silvics of the species must be compatible with the site. The Executive Director of the Saskatchewan Forest Service must approve any species that does not appear on this table. Source: (adapted from Acton et al. 1998)

2.1.2 Crop Tree

A crop tree is any acceptable tree (as listed in Table 1) of each species in a plot that has achieved the minimum height and leader growth requirements as defined in the standards for the type of survey and species.

2.1.3 Survey Block Area Boundaries

The same regeneration survey block area boundaries will apply to both the establishment and FTG assessments.

A harvest block is exclusive of inter-block roads. The survey block area is the harvest block area less all islands (contiguous polygons greater than or equal to 2 ha) of unharvested land (treed and non-treed) and the following provincially approved land uses that conflict with the forest renewal objectives of the renewal liability holder:

a. Dispositions including gravel pits, borrow pits, oil and gas pipelines and well sites, utility rights-of-way, and mineral extraction sites;
b. Research areas including, but not limited to, permanent sample plots;
c. Heritage properties;
d. Other areas as approved by the Executive Director of the Saskatchewan Forest Service (SFS).

The areas described above known to exist in the harvest block area must be deducted from the harvest block area to obtain the survey block area.

2.2 Establishment Assessment

2.2.1 Objective

Meeting the standards of the establishment assessment provides assurance, early in the regeneration phase of a harvested area, that adequate stocking of trees exists to contribute to the short-term development of new forest stands.

2.2.2 Standards

2.2.2.1 Survey Timing

An establishment assessment must be completed on a harvest block between four and five operating years after the end of the operating year of harvest (Figure 1) and at least one winter season after artificial regeneration activities have been completed on the block.

Establishment assessments are not to be done when snow accumulations are ≥ 5cm.

2.2.2.2 Plot Label

A plot must contain at least one acceptable tree to be designated sufficiently regenerated (SR). Plots not meeting this standard shall be designated not sufficiently regenerated (NSR).

2.2.2.3 Adherence to Procedures

All data collection procedures in section 3 and data compilation procedures in section 4 must be followed.

2.3 Free-to-grow Assessment

2.3.1 Objective

Meeting the standards of the FTG assessment provides reasonable assurance that achievement of the desired future forest condition is likely.

2.3.2 Standards

2.3.2.1 Survey Timing

The FTG assessment must be completed on a harvest block between 8 and 14 operating years after the end of the operating year of harvest (Figure 1) and must not be completed within two full growing seasons after the completion of a stand tending treatment.

2.3.2.2 FTG Height and Leader Growth Standards

Table 2 lists the FTG height and leader growth standards by species.

2.3.2.3 Plot Label

To be designated SR, a plot must contain at least one crop tree of a species listed in Table 2. Plots not meeting this standard are designated NSR.

Each SR plot must be assigned a species association label (S, SH, HS, or H) to facilitate classification of a survey block into a species association category. The procedure used to determine the plot species association label is described in section 3.3.2.10.

Table 2. Height and leader growth standards by species.

Attribute	Hardwood							Softwood				
	tA	bP	wB	gA	wE	bO	pC	wS	bS	jP	bF	tL
Minimum Height (m)	3.0	3.0	3.0	3.0	3.0	1.5	3.0	1.5	1.5	2.0	1.5	2.0
Minimum 3-year cumulative growth (cm)*	n/a	n/a	n/a	n/a	n/a	n/a	n/a	30	30	30	30	30

* Cumulative leader growth over the last three full growing seasons.
n/a – not applicable

2.3.2.4 Adherence to Procedures

All data collection procedures in section 3 and data compilation procedures in section 4 must be followed.

2.4 Regeneration Timeline

Figure 1 shows the timeline associated with harvest and regeneration assessment. Where a harvest block is cut over two successive operating years, the regeneration survey timeline will begin at the end of the most recent operating year of harvest.

After two successive years of harvesting in a planned block, any uncut portion of that block that is still planned for harvest must be assigned a new block number.

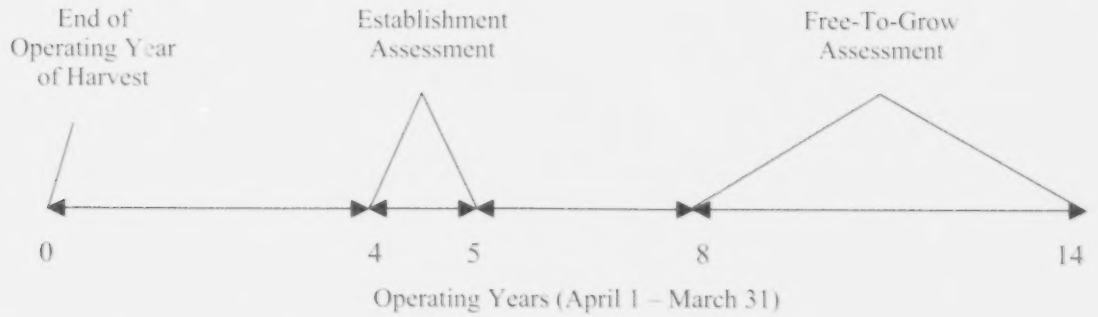


Figure 1. Regeneration survey timeline.

3 Survey Procedures

3.1 Selecting the Survey Procedure Type

a. Ground Survey
The ground survey procedures identified in Section 3 must be followed.

b. Aerial Survey
A renewal liability holder may submit a proposal to use aerial survey methods to assess pure hardwood or softwood blocks. The use of such methods must be approved by the Executive Director of the SFS for establishment or FTG assessments.

3.2 Field Layout

The sections that follow outline general procedures for field layout of the establishment and FTG surveys.

3.2.1 Line and Plot Numbers

A plot and line number identifies each plot centre. If additional lines are deemed necessary, each new line must be given the next number in the sequence.

3.2.2 Survey and Control Line Layout

Establish survey and control lines as follows:

a. Select a random start point for the survey and establish the survey grid based on a plot being located on that start point.
b. If necessary to maintain accurate positioning of survey lines, superimpose a control line on the survey grid, perpendicular to the survey lines (See Appendix 1 for an example), so that plot centres are located on it. Reference the control line to the harvest block boundary to enable accurate mapping of regeneration survey plot locations.
c. Double-flag survey line locations on the control line (if established), and clearly write the line and plot number on the flagging.
d. Locate the survey plots using either a compass/measuring tape, string measuring device or global positioning system (GPS) unit. All measured distances must use horizontal distance.

3.2.3 Plot Establishment

The regeneration survey plot is a circle with a 1.78 m radius (1/1000 ha or 10 m^2). The centre of the circle and the plot centre is a common point. Plots are established as follows:

a. Locate individual plots by compass and distance measuring device or GPS.
b. Clearly mark each plot centre in one of the following two ways:
    i. With flagging tape affixed to a stake or stick firmly anchored in the ground at the plot centre (renewal liability holders will in advance of marking, advise SE of their colouring scheme in operating plans). A living tree branch (1.0 – 2.0 m in height) may also be used. Write the plot number and line number on the flagging

with a black, waterproof permanent marker.

ii. Spray paint the plot centre, and on a shrub or tree near the plot centre, affix flagging tape to a branch. Write the plot number and line number on the tape with black, waterproof permanent marker.

3.2.4 Plot Deletion

If plots fall on areas described in section 2.1.3, that were not known to exist prior to the survey, they must also be deleted from the harvest block area for survey purposes. These areas, for which the renewal liability holder does not have an obligation to reforest, must be identified during the survey and recorded as a deleted plot with a "D" in the plot label field on the regeneration survey tally sheet. When a plot is deleted, the next plot is established at the regular inter-plot distance. If the plot still lands on the area that qualifies for plot deletion, continue to move to the next potential plot at the regular plot interval distance, until a valid plot can be established.

3.2.5 Plot Movement

All unharvested retention patches or riparian management areas $\geq$ 0.04 ha (20 m by 20 m) and less than 2 ha (with no evidence of harvest activity present) within a harvest block are considered part of the area to be regenerated and are included in the survey block area. However, the renewal liability holder is not required to establish plots in these areas during the regeneration survey. Instead, plots that fall on these areas are moved until they fall on harvested area.

In these instances, move the plot half the inter-plot distance toward the next plot to obtain the required number of plots, rather than adding plots later. If the plot still lands on the area that qualifies for plot movement, continue to move the plot at one-half the plot interval distance until a valid plot can be established. The next plot following a moved plot remains at its normal grid location.

Plots landing on temporarily flooded ground, slash piles, landings, in-block roads, and borrow and gravel pits outside road rights-of-way without an approved disposition are not to be deleted or moved.

3.2.6 Non-productive Areas

A plot that falls on an area that was incapable of supporting tree growth before harvest is a valid plot but should be tallied as a non-productive plot. These areas are primarily limited to wetlands or extremely rocky sites, incapable of tree growth. The entire area of the plot must have been without the capacity to grow trees prior to harvest. There must be no stumps present in these plots. These plots are valid plots in that they are included in the regenerating block. However, they are not included in the total plots for use in the survey block regeneration status.

3.3 Tally Sheet Completion

Regeneration assessment data is recorded on the ground survey tally sheet (located in Appendix 2 and a completed example is located in Appendix 3). The tally sheet can be modified for the renewal liability holder's needs as long as the electronically submitted information meets SE's requirements.

3.3.1 Header Information

The ground survey tally sheet contains header information required for the establishment and FTG assessment. Header information identifies the harvest block and provides background information on the survey block area. The following are descriptions of required attributes for the ground survey tally sheet, which are normally completed in the office prior to the survey.

3.3.1.1 Provincial Forest Area

The Provincial Forest Area is the official SE forest area descriptor for the forest where the block is located (See Appendix A of the Forest Operations Manual for a list of acceptable forest areas in Saskatchewan).

3.3.1.2 Renewal Liability Holder

The renewal liability holder is the party holding the reforestation liability for a harvest area. The renewal liability holder could be a Forest Management Agreement (FMA) holder, trust fund holder, Saskatchewan Environment, or other entity or organisation as designated by the Minister.

3.3.1.3 UTM Coordinates

The universal transverse mercator (UTM) coordinates of the approximate centre of the harvest block.

3.3.1.4 Surveyor Name(s)

Print the name(s) of the surveyor(s) that did the survey.

3.3.1.5 Harvest Date

The harvest date is the day, month, and year when all timber in the block is skidded to landings. Record this date numerically as dd/mm/yyyy.

3.3.1.6 Survey Type

Enter the appropriate type of survey (establishment or FTG) in this field.

3.3.1.7 Harvest Block Area

The renewal liability holder's harvest block area from their records.

3.3.1.8 Survey Block Area

The survey block area is the area identified in section 2.1.3.

3.3.1.9 Survey Grid

Enter the line and plot spacing in this field on the tally sheet. The regeneration survey layout requirement is a square grid pattern where the distance between lines equals the distance between

plots. Appendix 4 shows the procedure to determine line and plot spacing and square spacing distances for survey block sizes under 24 ha.

The survey grid is 60 m by 60 m once the survey block size exceeds 24 ha. Appendix 5 presents a table with square spacing distances, sample intensities, allowable errors and the number of survey plots required for a range of survey block sizes from 2.0 to 25.0 ha.

3.3.1.10 Sampling Intensity

The sampling intensity is the number of plots required based on the survey block area. Appendix 6 shows the formula used to determine the required number of regeneration survey plots. Appendix 5 lists the number of plots necessary for blocks between 2.0 and 24.0 ha. To determine the number of regeneration survey plots needed for survey block areas greater than 24 ha, simply multiply the survey block area by 2.77 and round the product to the nearest whole number.

3.3.1.11 Contiguous NSR Patches greater than 5 ha

Record the total area of contiguous NSR patches greater than 5 ha, using calculation procedures provided in section 3.3.4.3.

3.3.1.12 Unique Harvest Block Identifier

The unique harvest block identifier is comprised of the FMA, management unit (MU), operating area (OA), and block (BK) numbers combined. In a situation where no unique harvest block identifier exists, one must be generated.

3.3.1.13 Pre-harvest Stand Species Association

The pre-harvest stands within the harvest block area must be assigned species association designations for presentation on the tally sheet header to permit comparison with regeneration survey results on a landscape scale. This information is summarised in hectares. Use the procedure below to complete the pre-harvest stand species association designation.

When using the UTM Forest Inventory, the species association designation is as presented on the forest inventory map. Follow the example in Table 3 to assign a species association designation for a harvest block.

For a stand description developed according to the Saskatchewan Forest Vegetation Inventory (SFVI) standards, a species association is assigned to each stand or portion thereof comprising the harvest block to be surveyed. Follow the procedure in (a) below to designate the species association label for stands with a single tree layer (Appendix 7 provides an example). If the stand contains multiple tree layers use the procedure outlined in (b).

Table 3. Example of pre-harvest species association designation for a harvest block using UTM inventory.

Stand No.	Stand Label	Stand Designation and Area (ha)				Total Area (ha)
		S	SH	HS	H	
1	HS25B (ta-ws)			8		8
2	SH25C (ws-ta)		10			10
3	S20B (bs)	5				5
4	HS25C (ta-ws)			4		4
5	H20D (ta)				5.6	5.6
Total Area (ha)						32.6
Pre-harvest stand species association (ha): S 8.0; SH 10.0; HS 12.0; H 5.6						

a) If the stand contains only one tree layer, designate it:

- S, if ≥80 % softwood composition;
- SH, if softwood species composition is between 50 and 79 %;
- HS, if softwood species composition is between 21 and 49 %;
- H, if softwood species composition is ≤ 20%.

b) If the stand contains multiple tree layers ≥ 15 m in height, determine the proportion of crown closure (softwood vs. hardwood) as illustrated in Table 4 for all layers with a height ≥ 15 m and go to (c).

Table 4. Relative crown closure factor determination.

Stand layer	SFVI composition	Softwood numerator		Hardwood numerator	
Upper layer (canopy)	10 25 wS_8tA_2	10 x 8	80	10 x 2	20
Second layer (sub-canopy)	60 21 tA_8wS_2	60 x 2	120	60 x 8	480
Total			200		500

Softwood crown closure: 200/700 = 29%; Hardwood crown closure: 500/700 = 71%

c) Based on the relative crown closures of softwood and hardwood, apply the species association rules from (a) and determine the species association for the stand (i.e. based on the example above, the species association for this stand is HS).

3.3.1.14 Survey Date

The survey date is the regeneration survey completion date. Record this date numerically as dd/mm/yyyy.

3.3.2 Plot Data Collection

The following information is collected for productive valid plots (plots not deleted), which will contribute to regeneration status. Shown below is the regenerating stand information that must be collected during the field survey and recorded on the survey tally sheet. Each section

describes the standards required for plot measurements and completion of the appropriate fields on the tally sheet.

3.3.2.1 Species

For both the establishment assessment and the FTG assessment, enter the species symbol (Table 1) for each acceptable tree species present in a plot.

3.3.2.2 Advanced Growth

During both assessments, enter the species symbol in the "advanced growth" field if the tree measured for height in Section 3.3.2.3 is advanced growth.

3.3.2.3 Height

For the establishment assessment, record the height of the tallest crop tree for each species in the plot.

For the FTG assessment, record the height of the tallest crop tree for each species in the plot, except for the conifer tree species assessed for competition (Section 3.3.2.8). In this case, the conifer tree assessed for competition must be the tree measured for height and diameter and recorded for that species.

Height must be measured to the nearest centimetre for all trees ≤300 cm. The height of trees > 300 cm must be estimated to the nearest half-metre. The height of the tree is measured vertically from the base of the seedling/sapling, at the average ground level, to the tallest reaching point of the live matter of the tree. Leaning trees are not to be straightened for this measurement.

If the survey is done prior to July 15 of a given year, total height of conifers is measured from the point where the stem meets the ground surface to the end of the previous year's growth. If the survey is done after July 15, the total height is measured from the point where the stem meets the ground surface to the base of the terminal bud.

3.3.2.4 Stem Basal Diameter

Stem basal diameter measurements are recorded for both the establishment and FTG assessment on the same trees measured for height in Section 3.3.2.3.

Measure the diameter between 1-5 cm from the ground, perpendicular to the stem to the nearest millimetre using callipers or a small diameter tape (tree size dependent).

Although not used to determine plot or block status, the collection of this data will provide valuable information for analysis of regenerating stands and for future development of regeneration standards in the Province.

3.3.2.5 Softwood Three-year Height Increment

Softwood height increment measurements are required for the FTG assessment only.

For the FTG assessment, record the three-year cumulative growth of the same softwood trees measured for height in Section 3.3.2.3.

The cumulative height increment measures the internode length of the dominant leader for the previous three full growing seasons growth. Cumulative height increment must be measured to the nearest centimetre for all trees ≤300 cm in total height. Cumulative height increment of trees >300 cm can be estimated to the nearest 10 cm.

If the survey is done prior to July 15 of a given year, cumulative height increment is measured from the base of the current year's growth to the bud scar three years prior. If the survey is done after July 15, the cumulative height increment is measured from the base of the terminal bud to the bud scar three years prior.

3.3.2.6 Density

During the establishment and FTG assessments, the number of all acceptable trees, by species, must be counted for species with more than 20 stems on the plot. If the stem count for a given species exceeds 20 stems, all the stems in a quadrant sample are counted. At the first occurrence of this situation, the plot is divided into four quadrants, and all trees in the NE quadrant are counted. Multiply the value by four to estimate the number of stems in the plot. If the stem count for any of the other species in the plot exceeds 20, use this same procedure to estimate the density. When the stem count for a given species within a subsequent plot in the same block exceeds 20, the next quadrant to measure must be the SE, followed by the SW, NW, and then back to NE.

Although not used to determine plot or block status, the collection of this data will provide valuable information for analysis of regenerating stands, for future development of regeneration standards in the Province, and for linkage to growth and yield models.

3.3.2.7 Plots on In-block Roads or Landings

The occurrence of plots falling on in-block roads and landings is recorded to assess regeneration success on these sites compared to the remainder of the harvest block. Record a "Y" (yes) on the tally sheet for plots falling on in-block roads and landings, otherwise leave the field blank for plots not falling on in-block roads and landings.

3.3.2.8 Presence of Competition

During the FTG assessment, the presence of hardwood tree competition will be assessed for one softwood crop tree in the survey plot. The competition assessment indicates the presence or absence of hardwood tree competition greater than or equal to 2/3 the height of the softwood tree selected for assessment within a 1.78 meter radius (Figure 2) of the selected softwood tree's stem. If a hardwood tree meeting this criterion is present, a "Y" is entered in the appropriate cell on the survey sheet. Otherwise, an "N" is entered in this cell. Leave the field blank for tallied trees within a plot, which are not measured for competition. Presence of competition within a plot is used to help determine the plot species association label, as per section 3.3.2.10.

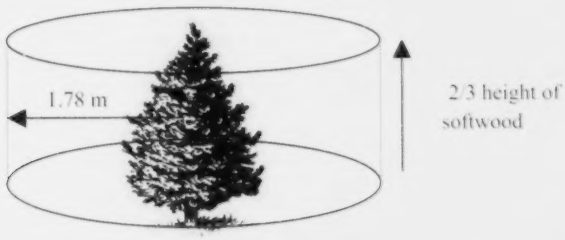


Figure 2. The competition radius used to evaluate hardwood tree competition relative to a selected softwood tree.

3.3.2.9 Site Comments

On the tally sheet, there is space to record general survey block comments that may indicate the cause of regeneration failure and provide input into remedial silviculture actions (i.e.- planting, tending, etc.) necessary to meet management objectives. Make comments on forest health issues for the survey block in this field. Note mechanical, insect or disease damage observed on the regenerating trees in the plot.

3.3.2.10 Plot Labels

Species association labels are not determined for plots in the establishment survey. During an establishment survey, a plot is labelled SR if it contains at least one acceptable tree (softwood or hardwood) and it is labelled NSR if it contains no acceptable tree. The SR or NSR label is recorded in the plot label field on the regeneration survey tally sheet.

During the FTG assessment, a plot which does not contain at least one crop tree is labelled NSR. A plot that contains at least one crop tree is assigned a species association label (Table 5). The species association label is determined based on the presence of hardwood and softwood stems within the plot and the presence of competing hardwood tree(s) in a 1.78 m radius to the softwood tree being assessed for competition. Figures 4 to 8 provide a series of examples that lead to the four species association labels. Figure 3 defines the symbols used in the examples.

Table 5. Survey plot species association label determination.

Number of trees/survey plot		Softwood tree competition radius free of hardwood tree(s) ≥ ⅔ the height of the softwood tree	Plot Species Association Label
Softwood	Hardwood		
≥1	0	Yes	Softwood (S)
≥1	≥1	Yes	Softwood/Hardwood (SH)
≥1	0	No	SH
≥1	≥1	No	Hardwood/Softwood (HS)
0	≥1	n/a	Hardwood (H)

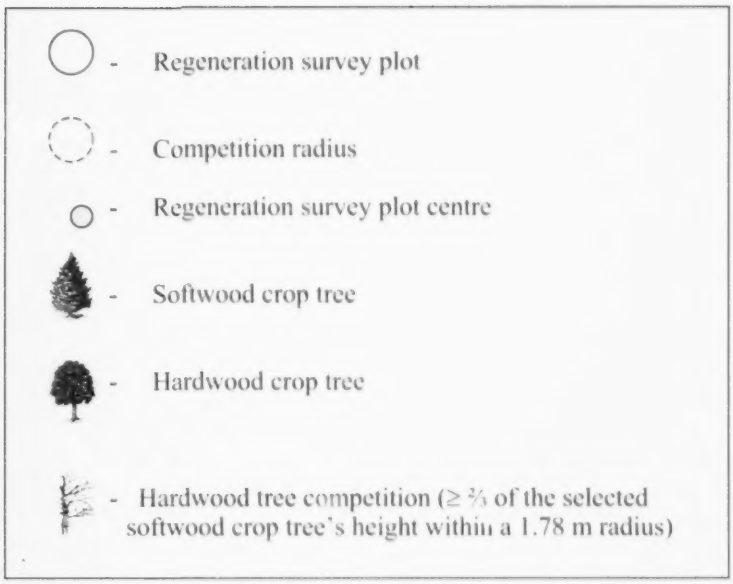

- Regeneration survey plot
- Competition radius
- Regeneration survey plot centre
- Softwood crop tree
- Hardwood crop tree
- Hardwood tree competition (≥ ⅔ of the selected softwood crop tree's height within a 1.78 m radius)

Figure 3. Definitions of symbols used in individual plot label illustrations.

3.3.2.10.1 Softwood Plot

To be assigned a softwood plot label, the plot must meet the following conditions (Figure 4):

a. the survey plot contains at least one softwood crop tree;
b. the survey plot does not contain any hardwood crop trees;
c. the competition radius around the softwood crop tree selected for competition assessment is free of any hardwood tree competition greater than two-thirds the height of the softwood tree around which it is assessed.

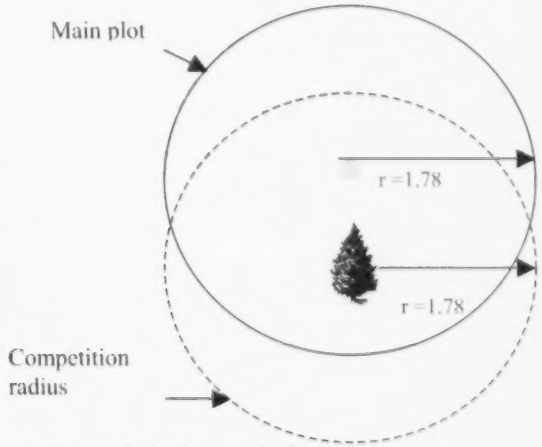


Figure 4. Example of a softwood-designated plot.

3.3.2.10.2 Softwood/Hardwood Plot

To be assigned a softwood/ hardwood plot label, the plot must meet the following conditions in either situation A or B (illustrated in Figure 5 and 6, respectively):

Situation A:

a. the survey plot contains at least one softwood crop tree and one hardwood crop tree;
b. the competition radius around the softwood crop tree selected for competition assessment is free of any hardwood tree greater than two-thirds of its height.

Situation B:

a. the survey plot contains at least one softwood crop tree;
b. the survey plot does not contain any hardwood trees;
c. the competition radius around the softwood crop tree selected for competition assessment is not free of hardwood tree(s) greater than two-thirds of its height.

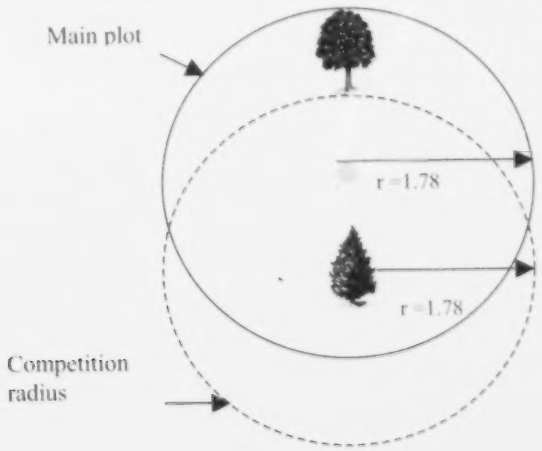


Figure 5. Example of a softwood/hardwood designated plot.

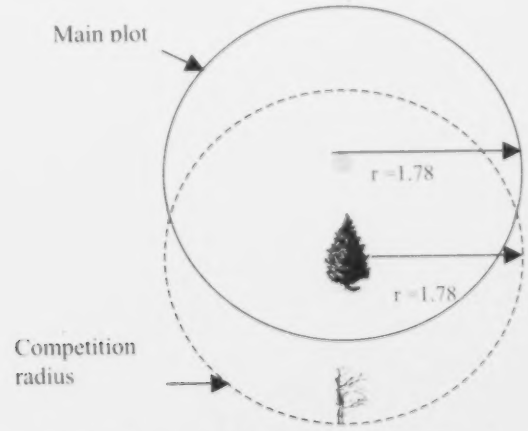


Figure 6. Example of a second situation leading to a softwood/hardwood designated plot.

3.3.2.10.3 Hardwood/Softwood Plot

To be assigned a hardwood/softwood plot label, the plot must meet the following conditions (Figure 7):

a. the survey plot contains at least one softwood crop tree and one hardwood crop tree;
b. the competition radius around the softwood crop tree selected for competition assessment is not free of hardwood tree(s) greater than two-thirds of its height.

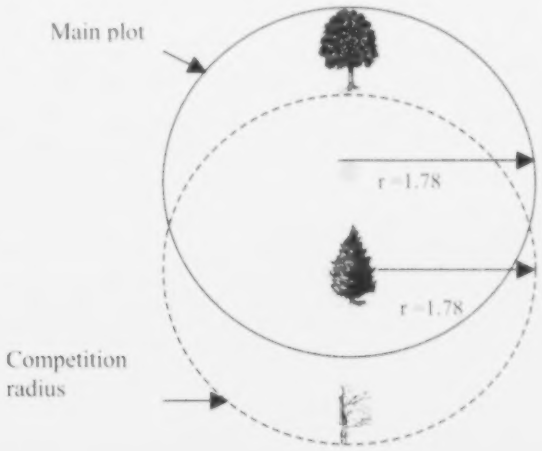


Figure 7. Example of a hardwood/softwood designated plot.

3.3.2.10.4 Hardwood Plot

To be assigned a hardwood plot label, the plot must meet the following conditions (Figure 8):

a. the survey plot contains at least one hardwood crop tree and no softwood crop tree(s);
b. competition assessment does not apply in this situation since no softwood crop trees are present.

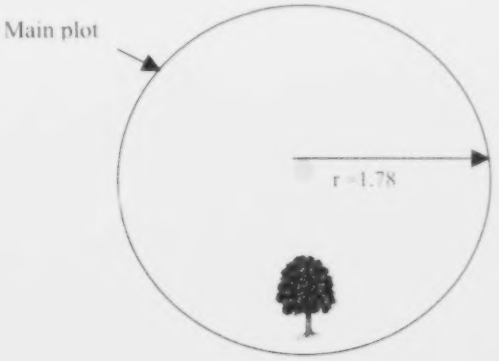


Figure 8. Example of a hardwood designated plot.

3.3.3 Field Calculations

The ground survey is systematic in nature and has been designed to meet a reasonable level of statistical accuracy, as presented in Appendix 6. The adequacy of sample size may need confirmation if 80% stocking is not achieved.

3.3.3.1 Adequacy of Sample Size

For NSR blocks 2 to 24 ha in size, the number of plots established must be checked to determine if the sample size requirements for statistical accuracy have been met. This procedure is as follows:

a. Calculate the establishment assessment stocking by counting the number of plots with at least one acceptable species present, multiplying by 100 and then dividing by the total number of all productive plots initially established;
b. Calculate the FTG assessment stocking by counting the number of plots with at least one crop tree, multiplying by 100 and then dividing by the total number of productive plots;
c. For NSR survey blocks 2 to 4 ha in size, 54 plots may be necessary to obtain the desired statistical accuracy, rather than the 41 established initially;
d. For NSR survey blocks between 4 and 24 ha in size, 84 plots may be necessary to obtain the desired statistical accuracy, rather than the 64 established initially;
e. If the block is defined by either c. or d. and the stocking is less than 80%, the renewal liability holder has the option to establish additional plots using the procedure described in section 3.3.3.2 and recalculate the stocking.

3.3.3.2 Adding More Plots

If additional plots are required to meet sample size requirements for statistical accuracy, they must be established as follows:

a. Add a new line halfway between every third completed survey line;
b. Plot spacing on the additional lines must be the same as on the original lines to facilitate delineation of SR/NSR areas;
c. If a new line every third line is not enough to add all of the plots needed, add lines between other survey lines to complete the necessary number of plots;
d. Plot numbers must continue sequentially from the last established line.

3.3.4 Regeneration Survey Map Preparation

Field maps must be prepared during a survey with a final map completed and submitted to SE, as per section 4.5. The following sub-sections of 3.3.4.1 list the required map content and format.

3.3.4.1 Map Content

Critical features and data must be recorded on the survey map as the surveyor progresses through the survey block. Appendix 1 illustrates a completed survey map. All submitted regeneration survey maps must have the following information included on the map sheet:

a. Provincial forest Area
b. Renewal liability holder
c. UTM coordinates
d. Unique harvest block identifier
e. Harvest date
f. Surveyor name(s)
g. Survey type (establishment or FTG assessment)
h. Survey date
i. Harvest block area
j. Survey block area
k. Number of plots required
l. Map scale
m. North arrow
n. Harvest block and survey block boundaries
o. Location and boundaries of deletions
p. Location of roads and landings
q. Location of survey lines and plots
r. Plot and line numbers
s. Control line
t. Azimuths of control line and plot lines
u. Declination
v. Plot status symbols
w. Delineation of NSR areas greater than 5 contiguous hectares in size

3.3.4.2 Plot Status Symbols

The plot status symbols presented below in Figure 9 are used on the survey map for both the establishment and FTG assessments. The symbols indicate location and presence of stocking that meets the regeneration standards. Determination of plot and block status is done during the compilation procedure.

- Deleted plot

NP - Non-productive plot

- SR plot

- NSR plot

- In-block road or landing (Add a square symbol around any plot falling on an in-block road or landing)

Example: NSR plot on an in-block road.

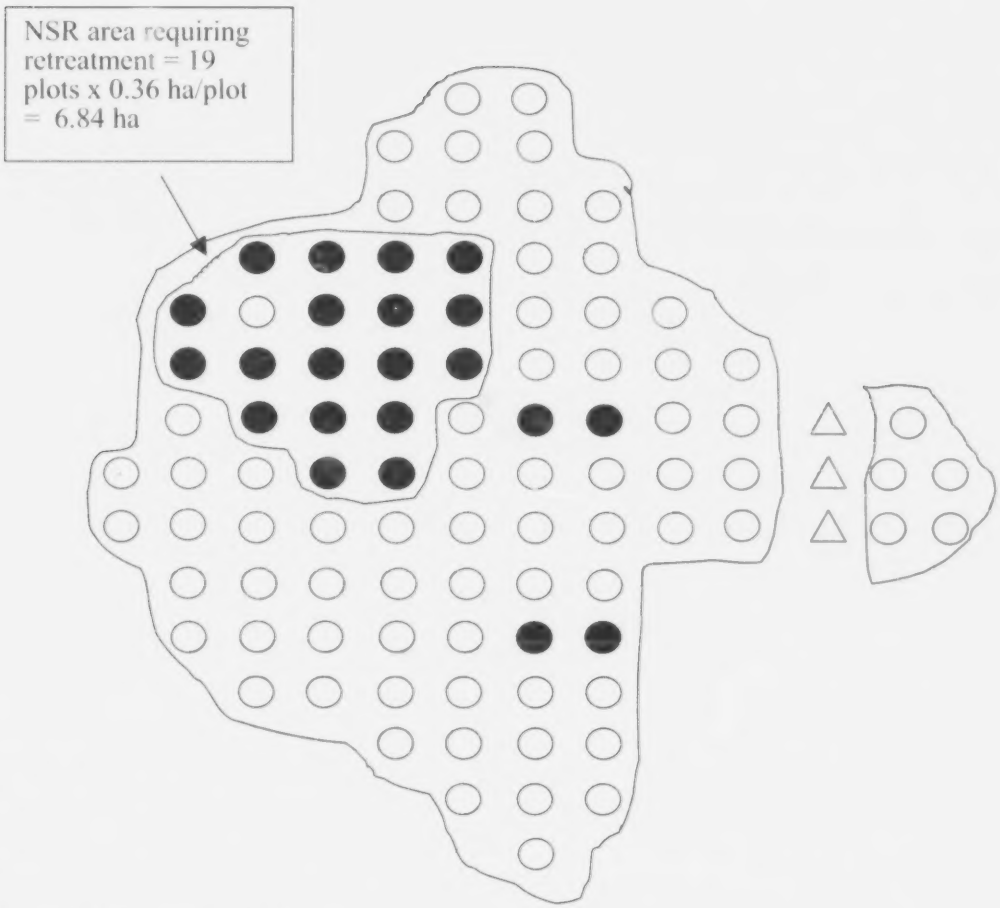
Figure 9. Survey map symbols.

3.3.4.3 Identifying NSR Patches

A block that satisfies the 80% stocking requirement will be designated NSR if contiguous NSR areas greater than or equal to 5 ha are identified on the field map for either the establishment or FTG survey. This procedure is not done if the block does not meet 80% stocking.

Delineation of NSR areas is done by encircling NSR plots that are surrounded on at least two sides by another NSR plot, or the block boundary. The calculation of the NSR area potentially requiring a retreatment plan is done by multiplying the number of these encircled plots (either NSR or SR) by the block area represented by each plot. If one or more NSR areas greater than or equal to 5 ha exist on the block, the entire block is declared NSR. Figure 10 provides an example of this procedure.

The combined area of 5 ha or greater contiguous NSR patches must be entered in the appropriate cell on the regeneration survey tally sheet.



Survey block area	33.1 ha
Productive plots	94
Grid at 60m x 60m	0.36 ha/plot
Total NSR	22 plots/94 = 23.4 %
Stocked	72 plots/94 = 76.6 %
NSR Void (>5ha)	19 plots = 6.8 ha

Figure 10. Example of NSR area requiring a retreatment plan.

4 Survey Compilation and Submission Procedures

Compilation and submission procedures are described in this section. Upon completion of regeneration surveys for an operating year, tally sheet information for all blocks requiring a survey must be compiled and submitted to Saskatchewan Environment in electronic format. The regeneration survey block summary format in Appendix 8 and 9 is provided to illustrate the manner in which SE may summarise the data received from renewal liability holders. Renewal liability holders are not required to submit this summary to SE. Further detail about when and how data is submitted will be provided in the Forest Planning Manual in the future. Prior to this time, proponents should contact SFS for interim direction on planning and reporting requirements.

4.1 Block Summary Survey Header Information

The same header information fields required on the survey tally sheet appear on the survey summary report. Sections 3.3.1 and 3.3.2 describe these fields. Appendix 10 describes additional fields used only in the regeneration survey block summary.

4.2 Survey Block Regeneration Status

If ≥ 80% of the productive plots are designated SR, the entire block shall be designated SR except where one or more NSR areas greater than or equal to 5 ha exist on the block (see Figure 10). In this latter case, the entire block is declared NSR. Plots are assigned one of four species association labels, as listed in Table 5. Subsequently, the block is given a species association designation as per Table 6.

A regeneration survey block with less than 80% SR plots shall be designated NSR.

4.3 Block Species Association Designation

Table 6 provides a matrix for designating block species associations.

Table 6. Species association matrix for SR blocks.

SR plot proportions	Block species association designation			
	Softwood (S)	Softwood/ Hardwood (SH)	Hardwood/ Softwood (HS)	Hardwood (H)
S plots ≥ 80%	X			
S + SH plots ≥ 50%		X		
H + HS plots ≥ 50%			X	
H plots ≥ 80%				X

*Note: Within a block where S + SH Plots = 50%, and H + HS Plots = 50%, it will default to an HS designation.

4.4 Survey Results

Survey results are summarized in this section through recording the number of SR and NSR plots according to plot label. Summaries of plot status are also provided, along with other attributes, as depicted in the example provided in Appendix 9.

4.5 Reporting Requirements

The following information must be provided for surveyed blocks in the annual report of forest operations:

a. A small scale map(s) showing the location of surveyed blocks by management unit in digital format acceptable to SE;
b. A large scale survey map for each block (a photocopy of the field survey map is acceptable);
c. Regeneration survey tally sheet data in a digital format acceptable to SE.

5 NSR BLOCK IMPLICATIONS

5.1 Establishment Assessment

Each block not meeting SR status (deemed NSR, either from the results of the establishment survey or in lieu of one) at the end of the establishment assessment period must be reported as such in the annual report of forest operations for that operating year, and include a remedial silviculture action plan. The remedial activity must be completed within two operating years of the operating year of survey.

Failure to develop and/or implement a remedial silviculture action plan for a survey block constitutes non-compliance that may result in a financial penalty.

Repeated failure to develop and implement remedial action plans for NSR blocks may result in further implications, including wood supply reductions, the assessment of financial penalties, and forest licence review.

5.2 FTG Assessment

Each block not meeting FTG status (deemed NSR, either from the results of the FTG survey or in lieu of one) at the end of the FTG assessment period must be reported as such in the annual report of forest operations for that operating year. No action plans will be accepted for these blocks unless approved by the Director of FEB.

Repeated failure to meet FTG requirements may result in wood supply reductions, the assessment of financial penalties, and forest licence review.

6 Literature Cited

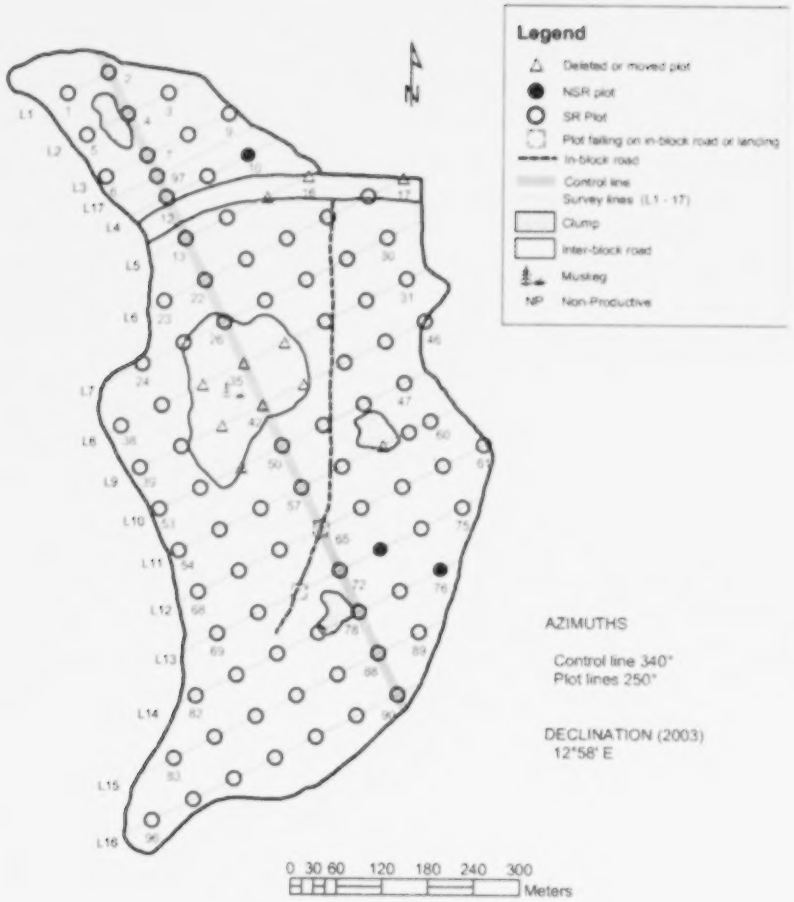
Acton, D.F., G.A. Padbury and C.T. Stushnoff. 1998. The ecoregions of Saskatchewan. Saskatchewan Environment and Resource Management (ed.). Canadian Plains Research Centre, University of Regina. 205 pp.

Alberta Environment. 2003. Alberta Regeneration Survey Manual. Alberta Sustainable Resource Development, Forest Management Branch. Edmonton, Alberta. 100 pp.

Beckingham, J.D., D.G. Nielsen and V.A. Futoransky. 1996. Field guide to ecosites of the mid-boreal ecoregions of Saskatchewan. Nat. Resour. Can., Can. For. Serv., Northwest Reg., North. For. Cent.. Spec. Rep. 6.

7 Appendices

Appendix 1. Completed Map Sheet



Provincial Forest Area: NPF N	Renewal Liability Holder: Thompson Forest Products Ltd.	
UTM Coordinates Zone 13, 4652E 5967N NAD 83	Unique Harvest Block Identifier: 14-127-052	
Harvest Date: 14/12/1990	Surveyor Name(s): Paul Maczek, Earl Bourlon	
Survey Type: FTG	Survey Date: 22/08/2003	
Harvest Block Area (ha): 35	Survey Block Area (ha): 31.5	Sample Intensity (No. of plots required): 87
Site Comments: Block was very well stocked with lots of ungulate presence.		

Appendix 2. Required Tally Sheet for Ground Surveys

Where more than one survey tally sheet is needed for a survey block, only the unique harvest block identifier, survey date, and page number must be included in subsequent tally sheets.

Provincial forest area:	**Renewal liability holder:**		
UTM coordinates:	**Surveyor name(s):**		
Harvest date:	**Survey type:** Establishment or FTG		
Harvest block area (ha):	**Survey block area (ha):**	**Survey grid:** _____(m) x _____(m) **Line spacing** **Plot spacing**	
Sampling intensity (No. of plots required):	Contiguous NSR Patches > 5 ha **(Total Area)**:		
Unique harvest block identifier:	Pre-harvest Stand Species Association:	Survey date:	**Page: of**

Line no.	Plot no.	Species	Advanced growth	Total height (cm)	Diam-eter (cm)	3-yr height increment (cm)	Density (#of trees per plot)	Plot on in-block road (Y, or blank)	Competit-ion (Y, N or blank)	Comments (health, competit-ion, etc.)	Plot label

Appendix 3. Completed Regeneration Survey Tally Sheet

Provincial forest area: NPFN	**Renewal liability holder:** Thompson Forest Products Ltd.		
UTM coordinates: Zone 13, 4652E5967N NAD83	**Surveyor name(s):** Paul Maczek, Earl Bourlon		
Harvest date: 14/12/1990	**Survey type:** FTG	**Harvest block area (ha):** 35	
Survey block area (ha): 31.5	**Survey grid:** 60 m Line spacing x 60 m Plot spacing		**Sampling intensity** (No. of plots required): 87
Contiguous NSR Patches > 5 ha (Total Area): 0	**Pre-harvest stand species association** (ha): S: 6.5 SH: 7.4 HS: 11.5 H: 7.1		

Unique harvest block identifier: 14-127-052							**Survey Date:** 22/08/2003			**Page:** of	
Line no.	Plot no.	Species	Advanced growth	Total height (cm)	Diam-eter. (cm)	3-yr height increment (cm)	Density (#of trees per plot)	Plot on in-block road (Y or blank)	Compet--ition (Y, N, or blank)	Comments (health, competit-ion, etc.)	Plot label
1	1	jP		120	1.4	50	3				**H**
1	1	wB		150	1.8		4				
1	1	tA		300	3.1		15				
1	2	bF		200	2.4	60	6		Y		**SH**
1	2	wB		230	2.7		7				
1	2	tA		260	3.1		8				
2	3	wB		290	3.4		1				**H**
2	3	tA		400	3.8		10				
2	4	bP		350	4.1		2				**HS**
2	4	JP		300	5.3	65	2		Y		
2	4	tA		450	2.4		6				
2	5		bS	200	2.4	60	4		Y		**HS**
2	5	wB		350	4.1		5				
2	5	jP		200	2.4	65	1				
2	5	tA		350	4.1		8				
3	6	wS		150	1.8	60	5		Y		**HS**
3	6	tA		200	2.4		9				
3	6	bP		400	4.7		6				
3	7	bP		300	3.5		1				**HS**
3	7	tA		400	4.7		1				
3	7	wS		170	2.0	50	7		Y		
3	8	tA		500	5.9		6				**HS**
3	8	wS		170	2.0		1		Y		
3	9		bF	600	7.1	50	4				**HS**
3	9	bS		160	1.4	40	5		Y		
3	9	tA		500	5.9		1				
3	9	bP		450	5.3		2				

Unique harvest block identifier: 14-127-052							**Survey Date:** 22/08/2003			**Page:** of	
Line no.	Plot no.	Species	Advanced growth	Total height (cm)	Diam-eter. (cm)	3-yr height increment (cm)	Density (#of trees per plot)	Plot on in-block road (Y or blank)	Compet--ition (Y, N, or blank)	Comments (health, competit-ion, etc.)	Plot label
4	10	sW		125	1.5	35	3				**NSR**
4	11	sW		250	2.5	40	4		N		**S**
4	12	tA		350	4.1		1				**HS**
4	12	Jp		250	2.9	50	6		Y		
5	13	Jp		200	2.4	40	7		N		**S**
5	14	Jp		350	4.1	40	2		N		**S**
5	15	D								Road	**D**
5	16	D								Road	**D**
6	17	D								Road	**D**
6	18	bF		200	2.4	55	6		N		**S**
6	19	jP		220	2.5	40	6		Y		**SH**
6	19	wB		230	2.7		7				
6	20	tA		350	3.2		1			Lots of shrubs	**HS**
6	20	jP		225	2.5	40	3		Y		
6	21	jP		240	2.6	50	3		Y		**HS**
6	21	tA		400	4.5		1				
6	22	wS		150	1.8	60	2		Y		**HS**
6	22	tA		400	4.5		6				
6	23	wB		350	3.3		4				**HS**
6	23	wS		160	1.8	60	2		Y		
7	24	wS		170	1.9	50	1		Y		**HS**
7	24	tA		400	4.2		1				
7	25	bS		160	1.9	40	3		Y		**HS**
7	25	bP		450	5.3		2				
7	25	wB		300	3.2		1				
7	26	D								Muskeg	**D**
7	27	bS		170	2.0	50	14		Y	Moist site	**HS**
7	27	bP		400	5.0		2				
7	28	tA		360	4.0		10				**H**
7	28	bP		400	4.8		6				
7	29	jP		200	2.2	40	3		Y		**HS**
7	29	tA		440	5.1		2				
7	30	tA		420	5.0		2				**HS**
7	30	jP		170	2.1	40	2		Y		
8	31	wS		160	1.9	40	3		Y		**HS**
8	31	tA		450	5.1		2				
8	32	wS		180	2.2	40	5		Y		**HS**
8	32	tA		450	5.1		2				
8	32	bF		40	0.3	0	2				

Unique harvest block identifier: 14-127-052							**Survey Date:** 22/08/2003			**Page:** of	
Line no.	Plot no.	Species	Advanced growth	Total height (cm)	Diam-eter. (cm)	3-yr height increment (cm)	Density (#of trees per plot)	Plot on in-block road (Y or blank)	Compet--ition (Y, N, or blank)	Comments (health, competit-ion, etc.)	Plot label
8	33	wS		190	1.8	30	2	N	Y	Terminal weevil damage	**HS**
8	33		bS	320	3.7	60	1				
8	33	bP		420	4.8		3				
8	34	D									**D**
8	35	D									**D**
8	36	D									**D**
8	37	bS		170	2.1	40	2		Y		**HS**
8	37	bP		120	1.8		1				
8	37	tA		330	3.1		2				
8	38	wS		190	2.4	40	2		Y		**HS**
8	38	bP		170	1.9		2				
8	38	tA		380	3.6		3				
9	39	wS		170	2.1	40	1		Y		**HS**
9	39	bP		370	3.1		1				
9	39	tA		380	3.6		1				
9	40	bS		170	2.1	40	2		N		**S**
9	40	tL		220	2.3	50	1				
9	40	wS		150	1.4	30	1				
9	41	D								Muskeg	**D**
9	42	D								Muskeg	**D**
9	43	D								Muskeg	**D**
9	44		bS	420	4.1	60	1				**HS**
9	44	bS		190	1.7	30	2		Y		
9	44	bP		420	3.0		1				
9	45	wS		200	1.9	40	3		Y		**HS**
9	45	tA		420	4.0		2				
9	46	wS		170	1.5	30	2		N		**S**
9	46	tA		180	1.4		1				
10	47	wS		200	1.9	40	1		Y		**HS**
10	47	tA		390	3.8		2				
10	48	wS		210	2.0	40	1		N		**SH**
10	48	tA		390	3.9		2				
10	49	wS		180	1.7	30	1		Y		**HS**
10	49	tA		360	3.5		2				
10	50	wS		160	1.6	40	1		Y		**HS**
10	50	tA		390	3.9		1				
10	50	bS		160	1.4	30	2				
10	50	bP		340	3.2		1				
10	51	D									**D**

Unique harvest block identifier: 14-127-052							**Survey Date:** 22/08/2003			**Page:** of	
Line no.	Plot no.	Species	Advanced growth	Total height (cm)	Diam-eter. (cm)	3-yr height increment (cm)	Density (#of trees per plot)	Plot on in-block road (Y or blank)	Compet--ition (Y, N, or blank)	Comments (health, competit-ion, etc.)	Plot label
10	52	bS		150	1.4	30	2		Y		**HS**
10	52	tL		440	4.3	50	1				
10	52	wB		310	2.9		2				
10	53	wS		170	1.6	40	1		Y		**HS**
10	53	tA		420	4.0		1				
11	54	sW		180	1.6	40	4		Y		**HS**
11	54	tA		380	3.7		4				
11	55	sW		170	1.5	40	1		Y		**HS**
11	55	tA		390	3.8		2				
11	55	wB		310	3.0		2				
11	56	bS		160	1.5	40	1		Y		**HS**
11	56	bP		370	3.6		1				
11	57	.	wS	440	4.3	60	1		Y		**HS**
11	57	tA		330	3.1		10				
11	58	tA		410	3.9		12				**H**
11	59		wS	700	7.1	70	1		N		**S**
11	60	wS		180	1.7	40	1		N		**S**
12	61	wS		170	1.6	40	1		N		**S**
12	62	wS		160	1.5	40	1		Y		**HS**
12	62	tA		390	3.8		4				
12	63	wS		160	1.4	30	2		Y		**HS**
12	63	tA		430	4.2		4				
12	64	tA		440	4.1		10				**H**
12	65	bF		150	1.3	30	1		Y		**HS**
12	65	tA		390	3.7		4	Y			
12	66	wS		200	1.9	50	1		N		**HS**
12	66	tA		380	3.6		5				
12	67	wS		180	1.5	40	1		Y		**HS**
12	67	tA		390	3.5		4				
12	68	wS		160	1.5	40	1		Y		**HS**
12	68	tA		400	3.9		5				
13	69	tA		420	4.1		7		N	Some insect defoliation	**H**
13	70	tA		400	3.9		9		N		**H**
13	71	wS		190	1.7	40	1	Y	Y		**SH**
13	71	tA		280	2.4		3				
13	72	wS		170	1.5	40	2		Y		**HS**
13	72	tA		380	3.5		5				
13	73	wS		25	0.2	0	1		N	Chlorotic	**NSR**
13	74	tA		370	3.5		2		N		**H**

Unique harvest block identifier: 14-127-052							**Survey Date:** 22/08/2003			**Page:** of	
Line no.	Plot no.	Species	Advanced growth	Total height (cm)	Diam-eter. (cm)	3-yr height increment (cm)	Density (#of trees per plot)	Plot on in-block road (Y or blank)	Compet--ition (Y, N, or blank)	Comments (health, competit-ion, etc.)	Plot label
13	75	wS		190	1.7	40	2		Y		**HS**
13	75	tA		370	3.5		5				
14	76	wS		20	0.2	0.1	1		N		**NSR**
14	77	tA		320	3.0		12		N		**H**
14	78	wS		200	1.8	50	1		Y		**HS**
14	78	tA		400	3.7		6				
14	79	tA		420	4.0		12		N		**H**
14	80	tA		400	3.9		8		N		**H**
14	81	tA		430	4.2		12		N		**H**
14	81	bP		390	3.7		5				
14	82	tA		440	4.2		8		N		**H**
15	83	tA		400	3.8		14		N		**H**
15	84	tA		340	3.0		12		N		**H**
15	85	tA		420	4.0		8		N		**H**
15	86	tA		440	4.1		9		N		**H**
15	87	tA		420	4.1		10		N		**H**
15	87	sW		40	0.1	10	5				
15	88	sW		160	1.3	44	1		Y		**HS**
15	88	tA		430	4.0		9				
15	89	tA		450	4.2		12		N		**H**
16	90	bS	180	1.7	38	1			Y		**HS**
16	90	tA	420	4.1		10					
16	91	tA	390	3.6		12			N		**H**
16	92	tA		420	4.1		9		N		**H**
16	92		bP	920	9.0		7				
16	93	tA		380	3.7		11		N		**H**
16	94	tA		400	4.0		10		N		**H**
16	95	sW		160	1.4	42	7		Y		**HS**
16	95	tA		400	3.7		6				
16	96	wS		200	1.8	52	1		Y		**HS**
16	96	tA		380	3.7		3				
16	96	bP		360	3.5		3				
17	97	sW		170	1.5	46	4		N		**S**

Appendix 4. Square Line and Plot Spacing Calculation

$$\text{Plot spacing} = \sqrt{\frac{Sa \times 10{,}000\ m^2/ha}{n}}$$

where, Sa = survey block area in hectares,
n = required number of plots.

Example:

To calculate the square spacing grid for a 15.4 ha survey block:

a. Using Appendix 5, $n = 64$

b. Plot spacing $= \sqrt{\frac{15.4\ ha \times 10000\ m^2/ha}{64}}$

$= \sqrt{\frac{154000\ m^2}{64}}$

$= \sqrt{2406.25\ m^2}$

$= 49.05\ m$

c. Rounding to nearest 0.1 m, plot spacing = 49.1 m.

For all survey blocks exceeding 24 ha, plot and line spacing must be 60 m by 60 m.

Appendix 5. Line and Plot Spacing

Square spacing distances, sample intensity, allowable error and regeneration survey plots required for a range of survey block sizes

Block Size (ha)	Area Represented by Plot(m^2)	Square Spacing (m)	Sample Intensity (plots/ha)	Allowable Error (+/-%)	Number of Regeneration survey plots Required
2.0	487.80	22.09	20.50	12.50	41
2.5	609.76	24.69	16.40	12.50	41
3.0	731.71	27.05	13.67	12.50	41
3.5	853.66	29.22	11.71	12.50	41
4.0	975.61	31.23	10.25	12.50	41
4.5	703.13	26.52	14.22	10.00	64
5.0	781.25	27.95	12.80	10.00	64
5.5	859.38	29.32	11.64	10.00	64
6.0	937.50	30.62	10.67	10.00	64
6.5	1015.63	31.87	9.85	10.00	64
7.0	1093.75	33.07	9.14	10.00	64
7.5	1171.88	34.23	8.53	10.00	64
8.0	1250.00	35.36	8.00	10.00	64
8.5	1328.13	36.44	7.53	10.00	64
9.0	1406.25	37.50	7.11	10.00	64
9.5	1484.38	38.53	6.74	10.00	64
10.0	1562.50	39.53	6.40	10.00	64
10.5	1640.63	40.50	6.10	10.00	64
11.0	1718.75	41.46	5.82	10.00	64
11.5	1796.88	42.39	5.57	10.00	64
12.0	1875.00	43.30	5.33	10.00	64
12.5	1953.15	44.19	5.12	10.00	64
13.0	2031.25	45.07	4.92	10.00	64
13.5	2109.38	45.93	4.74	10.00	64
14.0	2187.50	46.77	4.57	10.00	64
14.5	2265.63	47.60	4.41	10.00	64
15.0	2343.75	48.41	4.27	10.00	64
15.5	2421.88	49.21	4.13	10.00	64
16.0	2500.00	50.00	4.00	10.00	64
16.5	2578.13	50.78	3.88	10.00	64
17.0	2656.25	51.54	3.76	10.00	64
17.5	2734.38	52.29	3.66	10.00	64
18.0	2812.50	53.03	3.56	10.00	64
18.5	2890.63	53.76	3.46	10.00	64
19.0	2968.75	54.49	3.37	10.00	64
19.5	3046.88	55.20	3.28	10.00	64

Block Size (ha)	Area Represented by Plot(m^2)	Square Spacing (m)	Sample Intensity (plots/ha)	Allowable Error (+/-%)	Number of Regeneration survey plots Required
20.0	3125.00	55.90	3.20	10.00	64
20.5	3203.13	56.60	3.12	10.00	64
21.0	3281.25	57.28	3.05	10.00	64
21.5	3359.38	57.96	2.98	10.00	64
22.0	3437.50	58.63	2.91	10.00	64
22.5	3515.63	59.29	2.84	10.00	64
23.0	3593.75	59.95	2.78	10.00	64
23.5	3671.88	60.60	2.72	10.00	64
24.0	3750.00	61.24	2.67	10.00	64
24.5	3610.11	60.08	2.77	9.71	68
25.0	3610.11	60.08	2.77	9.61	69

Appendix 6. Sample Size Determination for a Population Proportion (Stocking) Obtained from a Systematic Random Sample.

A systematic random sample involves the selection of a random starting point, and then every *k*th member of the population is selected for the sample. Since the first item is chosen at random, all items have the same likelihood of being selected for the sample and therefore statistical methods used for simple random sampling can be applied. The plots comprising this systematic sampling methodology for regeneration assessment are effectively selected at random by using a random starting point for a pre-specified grid pattern. Although continuous variables such as total height are sampled in addition to the discrete random variable of stocking (the most important variable estimated from this survey), random sampling formulae for discrete random variables are used to compute sample statistics. This is justified since a larger sample size is needed to estimate a proportion than to estimate continuous variable. To describe how close a stocking estimate is to the true stocking on a block we need to use confidence intervals.

A confidence interval is a range of values constructed from sample (plot) data so that the parameter occurs within that range at a specified probability. The specified probability is called the level of confidence. For reasonably large samples, the results of the central limit theorem allow us to state that ninety-five percent of the sample means selected from a population will be within 1.96 standard deviations of the population mean. Intervals computed in this fashion are called the 95 % confidence interval. The 95 percent refers to the middle 95 percent of the observations. The remaining 5 % are equally divided between the two tails. The central limit theorem states that the sampling distribution of sample means is approximately normal when the sample contains at least 30 observations. Therefore, we can use a *z*-table that shows the areas under the normal curve to find the appropriate *z* values. At the 95 % confidence level, the *z* value obtained from the *z* table is 1.96. The *z* (or normal) distribution is used when the sample size is 30 or more because the *t* distribution approaches the normal distribution as sample size increases (i.e., the difference between the *z* and *t* values is minor).

The block stocking estimate is described by:

$$p = X/n$$

where, X is the number of stocked plots, and
n is the number of plots sampled.

The confidence interval for the stocking estimate is described by:

$$z = p \pm z\sigma_p$$

where, σ_p is the standard error of the stocking estimate. It measures the variability in the sampling distribution of the sampling estimates.

The standard error of the stocking estimate is described by:

$$\sigma_p = \sqrt{\frac{p(1-p)}{n}}$$

Therefore, the confidence interval for the stocking estimate (p) is:

$$p \pm z \sqrt{\frac{p(1-p)}{n}}$$

The sample size for a proportion depends on:

a. the desired level of confidence (here it is a 95 % level of confidence)
b. the permissible margin of error in the population proportion (here it is ± 0.1)
c. an estimate of the population proportion (here we use 0.8).

The required number of plots to estimate stocking for various block sizes to a specified precision (i.e. E, the allowable error) and with a 95 % level of confidence can be calculated using the formula:

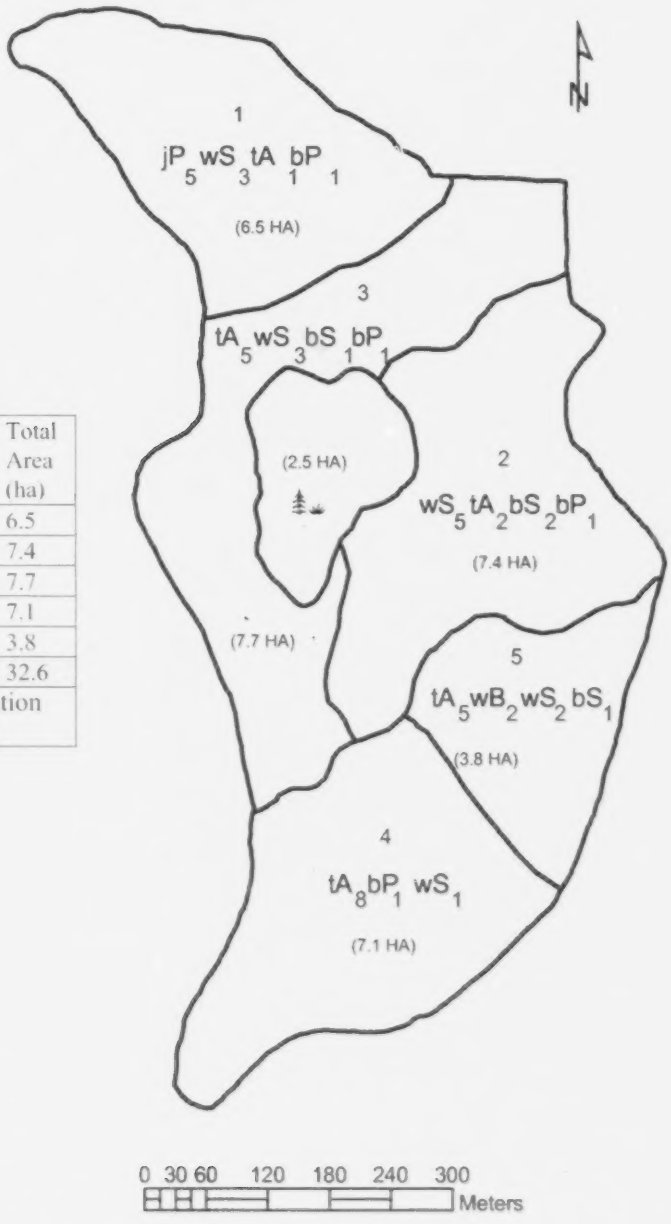
$$n = z^2 \, p \, (1 - p) \, / \, E^2$$

where:
- n = the number of regeneration survey plots required
- p = 0.8, the proportion of plots that are stocked. [The value of p is not known for the area prior to the survey, so an assumed stocking value of 80% (in most situations the expected value will be equal to or greater than the minimum standard for SR status, otherwise doing the survey would be inefficient) is used in the calculation.]
- q = $1 - p$;
- E = is the precision or the desired maximum allowable sampling error with which p is to be estimated (expressed as a proportion). For the regeneration assessment, the following allowable errors are permitted:
  a. +/- 0.10 for harvest blocks larger than 4 ha, or
  b. +/- 0.125 for harvest blocks 2 - 4 ha where the stocking result indicated by the survey is likely to be 80% or more, and
- z = 2, the z value at the 95 % confidence level obtained from a z-table (shows the areas under the normal curve given a confidence level). The actual z value for this confidence level is 1.96. Here, it is rounded to 2 to simplify calculation with a minor effect of increasing sample size.

For blocks between 2 and 4 ha, E is set at +/- 0.125 resulting in a sample size of 41 plots. For blocks greater than 4 ha, E is set at +/- 0.10 resulting in a sample size of 64 plots. However, for blocks greater than 24 ha, sample size is obtained by multiplying block area (in ha) by 2.77 plots/ha. The reason for using a constant sampling intensity on blocks larger than 24 ha is not statistical, but is solely to identify SR/NSR areas larger than 5 ha by covering the ground.

Appendix 5 shows the number of plots required to estimate stocking to a specified allowable error for various block sizes.

Appendix 7. Summary of Pre-Harvest Species Association for SFVI



Species Association Summary

Stand No.	Stand Designation & Area (ha)				Total Area (ha)
	S	SH	HS	H	
1	6.5				6.5
2		7.4			7.4
3			7.7		7.7
4				7.1	7.1
5			3.8		3.8
Total Area (ha)					32.6
Pre-harvest stand species association (ha): S 6.5; SH 7.4; HS 11.5; H 7.1					

Appendix 8. Regeneration Survey Block Summary

SURVEY INFORMATION				
Provincial forest area:		Renewal liability holder:		
UTM coordinates:		Unique harvest block identifier:		
Harvest date:		Surveyor name(s):		
Harvest block area (ha):		Survey block area (ha):		
Survey type:		Survey date:		
Pre-harvest stand species association (ha):				
SURVEY RESULTS				
PLOT STATUS	**PLOT LABEL**	**Number of Plots**	**% of productive plots**	**Post-harvest plot species association summary** (% of SR plots)
SR	S			
	SH			
	HS			
	H			
	Total SR plots			
NSR	NSR			
	Contiguous NSR Patches > 5 ha (Total Area)			
Total valid plots (S+SH+HS+H+NSR+NP)				
Deleted plots				
Non-productive (NP)				
Total plots (S+SH+HS+H+NP+NSR+D)				
Productive plots (Valid plots – NP)				
Density by species (sph): **jP, wS, bS, bF, tL, tA, wB, bP, other** (_____)				
Average density of all species (sph):		**Plots on in-block roads or landings** (SR/NSR):		
SR plots (%):				
SURVEY BLOCK REGENERATION STATUS:		**BLOCK SPECIES ASSOCIATION DESIGNATION:**		

Appendix 9. Completed Regeneration Survey Block Summary

SURVEY INFORMATION				
Provincial forest area: NPFN		Renewal liability holder: Thompson Forest Products Ltd.		
UTM coordinates: Zone 13 4652E 59671N NAD 83		Unique harvest block identifier: FMA870041U040020		
Harvest date: 1990/1991		Surveyor name(s): P. Maczek, E. Bourlon		
Harvest block area (ha): 35		Survey block area (ha): 31.5		
Survey type: FTG		Survey date: 22/08/2004		
Pre-harvest stand species association (ha): S: 6.5 SH: 7.4 HS: 11.5 H: 7.1				
SURVEY RESULTS				
PLOT STATUS	**PLOT LABEL**	**Number of Plots**	**% of productive plots**	**Post-harvest plot species association summary** (% of SR plots)
SR	S	9	10.5	10.8
	SH	28	32.6	33.7
	HS	20	23.2	24.2
	H	26	30.2	31.3
	Total SR Plots	**83**	**96.5**	**100**
NSR	NSR	**3**	**3.5**	
	Contiguous NSR Patches > 5 ha (Total Area)	**0**	**0**	
Total valid plots (S+SH+HS+H+NSR+NP)		**86**		
Deleted plots		**11**		
Non-productive (NP)		**0**		
Total plots (S+SH+HS+H+NP+NSR+D)		97		
Productive plots (Valid plots – NP)		**86**		
Density by species (sph): **jP** (442), **wS** (1070), **bS** (442), **bF** (221), **tL** (23), **tA** (4767), **wB** (372), **bP** (512), **other** ( )				
Average density of all species (sph): **7849**		**Plots on in-block roads or landings** (SR/NSR): 1/0		
SR plots (%): 96.5				
SURVEY BLOCK REGENERATION STATUS: SR		**BLOCK SPECIES ASSOCIATION DESIGNATION: HS**		

Appendix 10. Fields Used in the Regeneration Survey Block Summary

A number of fields are provided in regeneration survey block summary, which are provided in both Appendix 8 and 9 for reference purposes. This appendix provides details of how to fill in fields which are not required for reporting purposes.

a) Plot Status

The section on plot status summarizes the number of SR and NSR plots according to plot designation.

b) Number of Plots

The number of plots recorded in the survey are summarized in their representative field.

c) % of Productive Plots

The number of plots for each plot label (i.e. S,SH,HS,H and NSR) is divided by the total number of valid plots recorded during the survey.

d) Post-harvest Species Association Summary

The number of plots for each plot label (i.e. S,SH,HS,H and NSR) is divided by the total number of SR plots recorded during the survey.

e) Total Valid Plots

As depicted in the field, total valid plots are a summary of SR plots (S+SH+HS+H), NSR, and NP plots.

f) Non-Productive Plots

The number of non-productive plots encountered during a survey are recorded and must be consistent with section 3.2.6.

g) Deleted Plots

The number of deleted plots encountered during the survey is the total number of plots deleted and must be consistent with section 3.2.4.

h) Productive Plots

Productive plots represent the number of valid plots minus the number of non-productive plots encountered during the survey.

i) Density by Species

Density figures are summarized for each species present in the survey block and expressed as stems per hectare (sph). Density figures are calculated by totalling the density of each species

across all plots in the block, multiplying by 1000, and then dividing this figure by the total number of valid plots.

j) Total Density of all Species

The total of all species densities combined is calculated for the survey block.

k) Plots Falling on In-Block Roads or Landings

The number of SR and NSR plots falling on an in-block road (reclaimed or not) or landing is recorded for the survey block.

l) SR Plots (%)

SR plots are expressed in this field as a percentage of all plots

n) Survey Block Regeneration Status

The survey block is assigned either as SR or NSR.

o) Block Species Association Designation

This designation is calculated through the application of Table 6. This designation will apply to the block if it has successfully reached FTG status. The designation will remain until a forest inventory is completed for the block.